Multi-Period Supply Chain Network with Corporate Social Responsibility Incorporating Voluntary Duty, Bureaucracy, and Consumer's Participations in Under-Developed Countries

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***Abstract*-This paper presents the analysis of the effect of three motivational factors–voluntary duty, bureaucracy and consumers' participation on corporate social responsibility (CSR) activities in a multi-period supply chain network (SCN). Following the Cruz's (2009) analysis on SCN system, the optimal output level and the CSR activities in two-tier model consisting of manufacturer, retailer and consumer with motivation or incentive, might regularize the 'production-CSR activity' operation. This paper provides an extension of Cruz's (2009) model in SCN to compute the equilibrium pattern of product outputs, transactions, prices and level of CSR activities in a multi-period time frame. The result shows that the different range level (negative or positive) of CSR activity has an effect on bureaucratic performance and willingness in different time periods.**

Keywords-Bureaucratic Performance; Indirect Consumers' participation in CSR; Willingness; Incentives; Inelasticity; SCN-brain

I. INTRODUCTION

The study of Corporate Social Responsibility (CSR) incorporates economic, legal, ethical and philanthropic expectations imposed on organizations by society at a given point of time (Caroll and Bzchholtz, 2002). In recent years, enormous change im002). On the one hand, one school of thought argues that, the government should regulate the social and environmental performance of companies (Porter & Van Derlinde, 1995). On the other hand, some school thinks that the private sector generally prefers the flexibility of self-designed voluntary standards (UNCTAD, 1999). Many researchers have attempted to explain the motivation of voluntary performance of the CSR activities (Delmas & Terlaak, 2002). Swindley (1990) pointed out that many firms accept the CSR. What's more CSR activities can be considered as a way to uplift the reputation of a firm (Fombrum, 2001).

Mc Williams and Siegel (2001) asserted that the ideal level of CSR activities can not be determined. Again Falck and Heblich (2007), Porter and Kramer (2006) proposed the short-term and long-term level of CSR activities, where short-term performance need to be very strong and long-term effects need to be better understood. With these fremwork Cruz and Wakolbinger (2008) build a multi-tiered and multi-period supply chain model to analyze firstly how CSR activities impacts companies performance in the long run and how the level of CSR activities are influenced by factors within and outside a company.

To contribute to the above understanding we build a circular multi-tiered, multi-dimensional, and multi-period supply chain model by which decision makers can not only transact products and strategically allocate resources to CSR activities, manufacturers, retailers as well as demand maker can also have an urge to control the CSR level regularly in a continuous path. The analysis of the model provides insight on problems as follows: firstly, how decision makers get inspiration to do the CSR activities; and secondly, how the demand makers contribute to the CSR performance; finally, how all the tiers perform their responsibilities to control the CSR level. To solve those problems, it involves not only lower risk, lower emissions and lower costs in the long run but also the motivation factors which play a vital role to contribute to CSR activities regularly.

We exogenously include the *give and take* behaviors of decision makers within the circular supply chain as well. As to the structure, we endogenously include motivational factors in the incentive functions. The model is completely flexible to analyze how different objectives of a firm (Williams & Siegal 2001), how legal, institutional and motivational factors (Willliams & Aguilera 2008), and how countries' differences (Matten & Moon 2008), may impose effect on optimal CSR levels. Cruz and Wakolbinger (2008) considered CSR activities and risk management in a multi-period supply chain network framework.

In this paper, however, we turn to the critical issue of circular social responsibility activities with one motivational function, which is incentive function. As it is mentioned in the previous section, CSR activities faces many bottlenecks, which influence bureaucracy and consumers intellectuality and in turn become a motivational effect in the cost benefit analysis of CSR activities. These motivational effect or incentives were not considered by Cruz and Wakolbinger (2008). The circular supply chain model allows us to explicitly capture these motivational effects and hence, provides a valuable extension of previous research. Furthermore, it allows us to see how changes in the planning framework impact decision-making and the resulting payoffs and costs.

We have followed several assumptions from the computational model designed by Mcwilliams and Siegel (2001) and Cruz and Wakolbinger (2008). However, we follow some additional assumptions as:

i) It is assumed that all the manufacturers and retailers are more or less influenced by bureaucracy (A system of officialdom that is responsible for the implementation, management and execution of government policies).

ii) Manufacturers and retailers are willing to produce incentives and utilize them properly to perform CSR activities.

iii) Consumers desire to response and contribute to CSR activities to help to keep product quality and constant but periodically-changed product price.

iv) Manufacturers show their CSR performance through rank and product brand.

v) In the absence of any motivational power, product transactions from manufacturers to retailers and retailers to demand makers are equal.

This paper is organized as follows. In section two, we describe the importance of bureaucracy on production economics and its willingness to perform the CSR duty and generate incentives on the performance of CSR activities. In section three we develop the theoretical CSR model consistent with the three new attributes and their inter-linkages. In section four, we analyze the decision makers' optimizing behaviors and the establishment of governing equilibrium conditions. In section five, we describe the computational procedure and discuss the results. Finally, in section six and seven we summarize our results and suggest directions for future research.

II. THE IMPORTANCE OF SKETCH

The under-developed countries (UDC) where bureaucracy plays an important role may have an impact on motives of policies in both micro and macro level. Therefore, it is also required to have some degree of willingness to maintain the voluntary standard of CSR for the betterment of our future generation. Moreover, the feedback from the standard of CSR level is shown by products preference of those industries whose CSR weightage are higher on the product level when considering quality and price.

As what we see in the under-developed countries nowadays, very few industries perform the CSR activities followed by schools, hospitals, rationing and canteen subscription, etc. It exists only in the internal structural framework. However, the very marginal CSR activities on the external side, such as consumers who are not part of industries' internal framework, can be seen the ultimate runner of industries. If we consider the CSR activity as a duty for corporate sector, there are also some rules and regulations to maintain this. And one may perform the duty if there is no way to escape. The level of duty is negative if bureaucracy is in cruel form. Country like India, where bureaucracy shows its ugly face from region to region, interferes in performing the CSR duty. Since the inference level is very high particularly in under-developed countries, we can say that the corporate sectors who perform their CSR duty are earning their own interest. Therefore, the willingness to perform the CSR duty in self-interest is also required to be included in the CSR model as far the UDC is concerned.

The corporate business person can never spend money or fufill their interest on CSR unless they get the extra incentive that is at least equal to the cost of CSR activity. Therefore, retailers, consumers or demand makers can only support the CSR sustainability and the feedback through the incentives which are the sole engine of production process. Consumer needs to show their preference on those goods / products, not only by the quality or price but also by CSR activity level with same weightage.

Therefore, from the above explanation it is required to incorporate the three vital entities vig, level of bureaucracy, self-interest to do the CSR activities, acquire consumer's feedback, and complete the CSR model, as far as the UDCs like India is concerned. In this connection, we made an incentive function that incorporates bureaucratic activities and willingness for corporate sector to perform social responsibility. However, in this paper particularly, we set the bureaucratic activities and willingness as a function of 'production level' and 'social responsibility performance level' in the corporate sector. Moreover, the production and CSR are the two factors that generate bureaucracy and willingness. Because the exact production-distribution CSR level, the supply-demand relationship, the effectiveness of 'bureaucracy on productive sector'(economic and social/service sectors), 'willingness on CSR-performance' and therefore the 'incentives for manufacturer', apparently will have no result. Thus the inadequacy or paucity in the UDC plays a vital role to determine the level of bureaucracy and willingness.

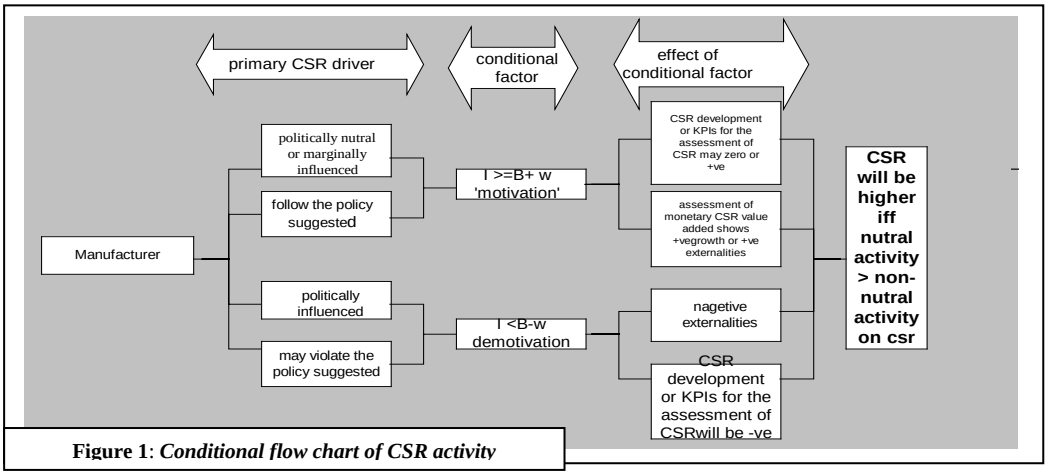


Figure 1: ***Conditional flow chart of CSR activity***

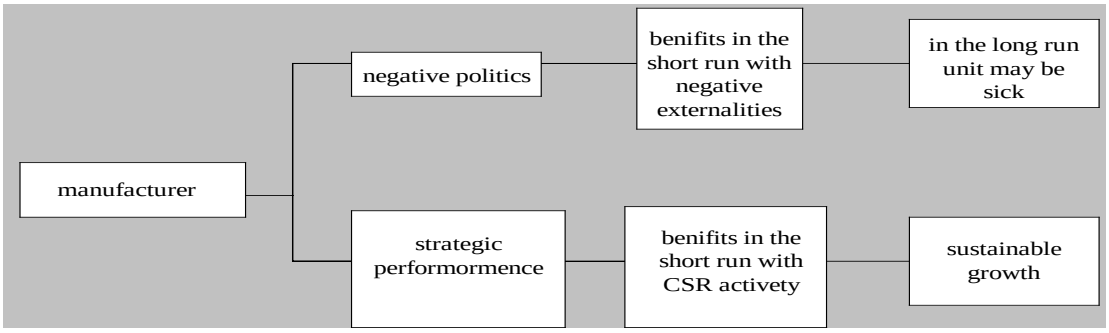
III. MODEL FORMULATION

This section deals with the theoretical description of a relationship among the incentive (I) willingness (W) and bureaucracy (B) with manufacturer. To show the above Linkage, we have constructed a conditional flow chart of CSR activity in Fig-1. The chart illustrates the manufacturer's CSR activity with bureaucratic influence or without bureaucratic influence in less-developed countries.

Sometime bureaucracy may plays the primary role to drive the production process. However, the conditional factor shows that the magnitude of other two attributes may suppress the negative bureaucracy or some time opposite. Here the KPI implies the key performing indicators (monitory and non-monitory) shows the business benefits from CSR as described by Weber (2008). Therefore, the effects on CSR as well as in production will be either positive for the upper flour or the negative result for the lower flour. Thus the degree of performance on CSR definitely is higher if and only if the manufacturers are not being influenced by the negative bureaucracy.

The long run CSR performance and its sustainability can also be seen in the figure 2.

Figure 2: ***Long run profile for sustainability***



A. The chain reaction between the production and incentives

As we see from the primitive stage, the production unit in micro or macro level generates several types of economic entities which focus on the social, political, economic and environmental structure. For instance the rural production pattern determine the rural socio-economical structure; production and market competition create politics on production policies (Stone, 1983); income creates demand; price level depends on aggregate demand, and production affect the ecology. However, these types of market forces are conventional in nature. Again the different types of oligopoly market apparently relate with political economy and thus are definitely parts of bureaucracy. Therefore, we can assume that the production is the core unit from where market forces, environmental hazards, socio-political problems etc. are flowing and push/back one another in a circular way. A circular flow diagram from the above chain reaction can be represented in figure 3.

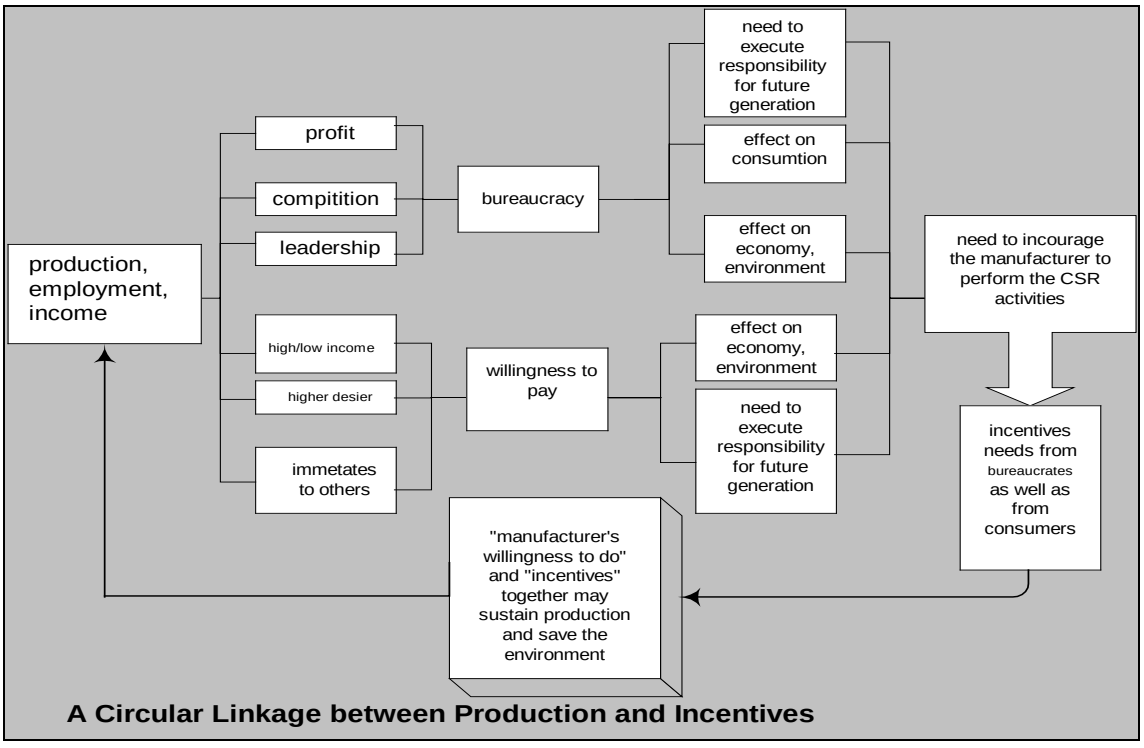


Figure 3

B. Evaluation of strategic relevance of incentives

As it is argued above, the assessments of qualitative impacts and key performing indicator can provide significant information for business benefits but may not get any monetary assessment. Therefore, the value-added CSR can never be considered as the final basis for a conclusion about the value of specific CSR activity to a company. Indeed, companies should prioritize the level of magnitude of CSR benefit based on the incentives backed by bureaucracy and consumers' willingness to prefer the product according to the contribution to the CSR strategy of the company. This leads to the level matrix shown in Table1. High level of CSR activities

Tab1 express that the negative level of bureaucrats activities ranked 'negative one' indicated a negative intensity in both dimensions of the matrix, and it should have the least priority for the decision on bureaucrats activities. For the term 'Incentives' we have taken "willing for CSR activity" in one dimension and "manufacturers' unwillingness to accept feedback for CSR activity from either side in another represent zero level of bureaucrats activity (manufacturers are unable to influence the bureaucrats to get incentives). The positive or low level of bureaucrats activities ranked 'greater and lower' indicated the 'support from consumer' in the one dimension and 'negative feedback' in another.

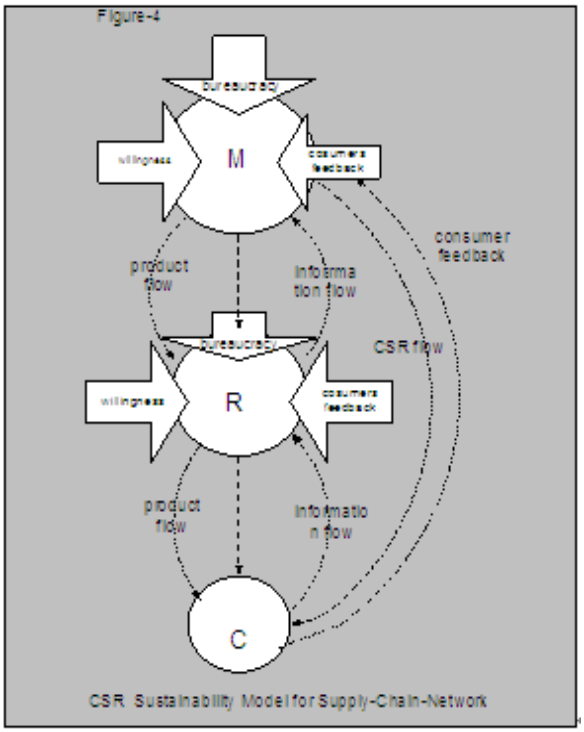
Table 1 A level Matrix of a Game between manufacturer and CSR activity

	M A N U F A C T U R E R		
C S R A C T I V I T Y		**WILLING & Motivated For CSR activity**	**NOT-WILLING& De-Motivated For CSR**
	WILLING & Motivated For CSR activity	High or+ve level of beaurocratic activity	zero level of beaurocratic activity
	NOT-WILLING & De-Motivation For CSR	Low level of beaurocratic activity	Negative level of beaurocratic activity

C. The basic model on supply chain network in respect of under-developed countries

Supply chain networks have very critical shape in production and distribution of goods in today's modern economics, since they are required to compromise on not only the internal structure but also the external pressure like politics. Therefore it is legitimate for UDC's to provide foundation upon which a local supply chain network model can be built that captures both internal (manufacturer, retailers, and consumers) and external factors (bureaucracy) that derives the total production process in under-developed countries. As it is seen in decentralized supply chain network (Cruz et al, 2005) the manufacturer, retailers and consumer have a strong linkage among them. If we suppose the manufacturers are the head of the management, then the total supply chain as seen in Figure-4, is required to become a rank one in terms of their contribution based on the support by the consumer as well as by bureaucrats. This level of CSR activities of a company reflects the main value of CSR and should guide the decision on current and future CSR activities. The fact is that, the under-developed or developing countries are suffering from unsystematic bureaucratic activities in corporate sector. This situation generates from production and other activities like social activites. From primitive societies we see that, without production or utiliriasm, society may suffer from politic al hazards. In this study the level matrix table shows the activities of the CSR and management in the production sector may have an effect on bureaucratic performance.

However, the manufacturer may be functioned with many elements (eg. bureaucracy, willingness to do, behavior, culture etc.). To incorporate factors like bureaucracy and willingness, we have constructed the SCN-brain as in Fig4.Thus the basic structure of SCN can be constructed as Figure5 to sustain the CSR in the production sector. The dotted directional line indicated the movement of relations or transactions. The above discussions have included in the optimization problem with the functional form of Incentives. However, this is the one aspect out of many, we have tried to highlight as far the CSR in the UDC.



Cruz and Nagurney (2005) have formulated the super network structure of supply chain model. Our paper has followed the structure and included one more functions, namely the function of incentives, and examines the optimality conditions and the distinctions.

IV. The Multi-Period Supply-Chain Network Model with Incentive

In this section we develop the incentives function and included it with the model of multi-period supply chain network which Cruz and Wakoilbinger devised in 2008.

All the variables, parameters are described in Table 2.

Table 2

Assuming indicators	Description
1…, t……T	Discrete fixed time horizon
i, j, k	Typical manufacture, retailers, demand makers respectively
*	Equilibrium solution
All vectors	Column vectors except where noted
All products	Homogenous products
(i, t)	Manufacturer i in time period t
(j, t)	Retailer j in time period t
(k,t)	Demand maker k in time period t
λ	Lagrange multiplier or shadow price
All prices and cost	Expressed in terms of their value in period 1
I, B, W, S	Incentives, Bureaucracy, willing to take or give, Automatic CSR performance respectively.

In the last row of this table we represent the four new variables. 'I' indicates the motivational factor or the incentive factor as a whole. The 'B' indicates the bureaucratic performance where 'B-'represents the negative performance and 'B+' shows the effective power of motivation. The W shows the willingness for the both decision makers as well as demand makers. In addition, the variable 'S' indicates the autonomous CSR performance. The variables $\left(Q^1, Q^1_{it}, Q^2, Q^2_t, Q^2_{jt}, \eta^1, \eta^1_{it}, \eta^2, \eta^2_{jt}, \rho_3, \rho_{3t}\right)$ as in the super network model we followed, with some new variables in Table-3. The model is comprises with several functions followed by 'Cruz et.al-2005' and these are consistent with transaction cost, handling and unit transaction cost, cost for social responsibility activities, the emission, risk, cost of production, demand. However, the newly formulated incentives function has been represented in Table – 4. Most empirical or conceptual researches on CSR did not focus on the management of incentives considering the perspectives of UDCs. In economics or sociology an incentives is any factor (financial or no financial) that enables or motivates a particular course of action or counts as a reason for preferring one choice to the alternatives. It is an expectation that encourages people to behave in certain ways. In this paper the incentives has been taken as a function of 'bureaucracy' and 'willingness to take by the manufacturer i' and these ultimately may effect motivates on output level and CSR activities in a particular company as seen in the Under-developed countries. Juttner et al. (2008) indicated that the supply chain relevant risk sources are consistent with three categories: environmental risk sources (e.g., fire, social-political actions, or 'acts of God'), organizational risk sources (e.g., production uncertainties), and network-related risk sources. Johnson (2001) and Norrman and Jansson (2004) argued that network-related risk arises from the interaction between organizations within the supply chain, e.g., due to insufficient interaction and cooperation. The target was to minimize the risk from social responsibility activities. However, the risk and uncertainty is a part of investment but we are required to have some motivational factors that instigate inspiration to reach the goal in the socio-economic and environment. Now we turn to express the behavior of the various economic decision makers with a motivational factor. The model has represented the case of a single homogeneous product. We first focus on manufacturers, then we turn to the retailers, and finally to consumers.

Table 3: Variables for the incentive formulation

Notation	Definition
B^1_{it} B^2_{jt}	t-dimensional vector of levels of bureaucratic activities on manufacturer i at time period 1 to t t-dimensional vector of levels of bureaucratic activities on retailer j at time period 1 to t
W^1_{it} W^2_{jt}	t-dimensional vector of levels of willingness to take by manufacturer i at time period 1 to t t-dimensional vector of levels of willingness to take by retailer j at time period 1 to t
S^i_t S^j_t	It represents the automatic CSR performance, taken -1; Here -1 implies CSR performance is negative for internal and external $\forall i = 1, 2,\ j = 1, 2, t = 1, 2,$
I^1_{it} I^2_{jt}	t-dimensional vector of levels of incentives on manufacturer i at time period 1 to t t-dimensional vector of levels of incentives on retailer j at time period 1 to t
L_{1ijt} & G_{1ijt} L & G	The parameter taken for 'CSR performance by the manufacturer on bureaucratic activities' at time period t. The parameter taken for 'CSR performance by the retailer on bureaucratic activities' at time period t.

A. The multi-dimensional decision-making behavior of the manufacturer with incentive and their optimality conditions

Let ρ^i_{1jt} be the price for the manufacturer i in transacting with retailer j in period t. The price ρ^i_{1jt} is an endogenous variable that requires determining the equilibrium SCN model.

The product flow needs to satisfy the following equation,

$$q_t^i = \sum_{j=1}^{J} q_{jt}^i, \quad (1)$$

The level of CSR activities at each period η_t^i. Therefore, the optimization problem for manufacturer i can be expressed as follows:

Maximize

$$\sum_{t=1}^{T}\left[\sum_{j=1}^{J}\rho_1^i q_{jt}^i - f_t^i\left(q_t^i,\eta_{it}^i\right) - \sum_{j=1}^{J} c_{jt}^i\left(q_{jt}^i,\eta_{it}^1\right) - b_t^i\left(\eta_{it}^1\right)\right] \quad (2)$$

c_{jt}^i = transaction cost for i and product flows to j at time t.

f_t^i = production cost for manufacturer i at time t.

b_t^i = CSR cost for manufacturer i at time t.

Subject to the constraints: $q_{jt}^i \geq 0$, and

$0 \leq \eta_t^i \leq 1, \forall i, j, t.$

The profit maximizing equation comprises with revenue, production cost, transaction cost and the cost for CSR for manufacturer i.

Besides the goal of profit maximization, the every manufacturer i also has a target to minimization the total emission (waste) generated in the production and transaction to the subsequent tier. This criterion of manufacturer i is indicated as,

Table 4: The incentive function

Notation	Definition
$I_t^i\left[B_{it}^1\left(Q_{it}^1,\eta_{it}^1\right).,W_{it}^1\left(Q_{it}^1,\eta_{it}^1\right)\right]$	Incentive function associated with manufacture i at period t
$I_t^j\left[B_{jt}^2\left(Q_{jt}^2,\eta_{jt}^2\right).,W_{jt}^2\left(Q_{jt}^2,\eta_{jt}^2\right)\right]$	Incentive function associated with retailer j at period t

$$\text{Minimize } \sum_{t=1}^{T} e_t^i\left(Q_{it}^1,\eta_{it}^1\right) \quad (3)$$

Subject to $q_{jt}^i \geq 0$, and $0 \leq \eta_t^i \leq 1, \forall i, j, t.$

e_t^i = emission by the manufacturer i at time t.

Therefore, the goal is to minimize the risk and can be expressed as,

$$\text{Minimize} \quad \sum_{t=1}^{T} r_t^i\left(Q_{it}^1,\eta_{it}^1\right) \quad (4)$$

Subject to $q_{jt}^i \geq 0$, and $0 \leq \eta_t^i \leq 1, \forall i, j, t.$

In addition to the above four mathematical formulation, we also assume that each manufacturer i has a target to maximize the total incentive level and can be expressed mathematically as,

$$\text{Maximize } I_t^i\left[B_{it}^1\left(Q_{it}^1,\eta_{it}^1\right).W_{it}^1\left(Q_{it}^1,\eta_{it}^1\right)\right] \quad (5)$$

Subject to $q_{jt}^i \geq 0, \quad 0 \leq \eta_t^i \leq 1, \quad \forall i, j, t.$

The manufacturer assigns a non-negative weight ϖ_2^i to total emission, ϖ_3^i to risk and weight ω_4^j to incentives. The numerical value for each weight has been set equal to 1. If we suppose that the same value of weights remains in incentive function then the importance of there weight value may transform into monetary units. Since for any motivational convocation through bureaucracy and consumer's feedback, there is increment not only on the output level but also on the dustup of CSR activities. These increments can be valued by multiplication of the partial derivatives with unit price. Therefore we can now construct a monetary value function for each manufacturer (Keeney & Raiffa, 1993) by applying a constant additive weight value function. Thus, the (2), (3), (4), (5) construct the multidimensional decision making with incentive problem of manufacturer i, can be mathematically expressed as,

Maximize:

$$\sum_{t=1}^{T}\sum_{j=1}^{J}\rho_1^i q_{jt}^i - f_t^i\left(q_t^i,\eta_{it}^i\right) - \sum_{j=1}^{J} c_{jt}^i\left(q_{jt}^i,\eta_{it}^1\right) - b_t^i\left(\eta_{it}^1\right) - \varpi_2^i e_t^i\left(Q_{it}^1,\eta_{it}^1\right) - \varpi_3^i r_t^i\left(Q_{it}^1,\eta_{it}^1\right) + \omega_4^j I_t^i\left[B_{it}^1\left(Q_{it}^1,\eta_{it}^1\right).W_{it}^1\left(Q_{it}^1,\eta_{it}^1\right)\right] \quad (6)$$

Subject to $q_{jt}^i \geq 0, \quad 0 \leq \eta_t^i \leq 1, \qquad \forall i, j, t.$

The equation (6) comprises with profit maximization, weighted emission to be minimize, weighted risk to be minimize, and the last term highlights the weighted incentives, which is to be maximize.

Thus, the Nash-equilibrium condition for all manufacturers with incentives function characterized non-cooperative operation, can be mathematically expressed as the variation inequality in Cruz (2008) and Bazaraa et al (1993) determine

$\left(Q^*,\eta^{1*}\right) \in \kappa^1$ satisfying

$$\sum_{t=1}^{T}\sum_{i=1}^{I}\sum_{j=1}^{J}\left[\frac{\partial f_t^i\left(q_t^{1*},\eta_{it}^{1*}\right)}{\partial q_{jt}^i} + \frac{\partial c_t^i\left(q_t^{1*},\eta_{it}^{1*}\right)}{\partial q_{jt}^i} + \omega_2^i\frac{\partial e_t^i\left(q_t^{1*},\eta_{it}^{1*}\right)}{\partial q_{jt}^i} + \omega_3^i\frac{\partial r_t^i\left(q_t^{1*},\eta_{it}^{1*}\right)}{\partial q_{jt}^i} - \rho_{1jt}^{i*} - \frac{\partial I_t^i\left[B_{it}^1\left(Q_{it}^{1*},\eta_{it}^{1*}\right),W_{it}^1\left(Q_{it}^{1*},\eta_{it}^{1*}\right)\right]}{\partial q_{jt}^i}\right]\times\left[q_{jt}^i - q_{jt}^{i*}\right]$$

$$+\sum_{t=1}^{T}\sum_{i=1}^{I}\sum_{j=1}^{J}\left[\frac{\partial\sum_{t=1}^{T} f_t^i\left(q_t^{1*},\eta_{it}^{1*}\right)}{\partial\eta_t^i} + \frac{\partial\sum_{t=1}^{T} c_{jt}^i\left(q_t^{1*},\eta_{it}^{1*}\right)}{\partial\eta_t^i} + \frac{\partial\sum_{t=1}^{T} b_{jt}^i\left(\eta_{it}^{1*}\right)}{\partial\eta_t^i} + \omega_2^i\frac{\partial\sum_{t=1}^{T} e_{jt}^i\left(q_t^{1*},\eta_{it}^{1*}\right)}{\partial\eta_t^i} + \omega_3^i\frac{\partial\sum_{t=1}^{T} r_{jt}^i\left(q_t^{1*},\eta_{it}^{1*}\right)}{\partial\eta_t^i} + \varpi_4\frac{\partial\sum_{t=1}^{T} I_t^i\left[B_{it}^1\left(Q_{it}^{1*},\eta_{it}^{1*}\right),W_{it}^1\left(Q_{it}^{1*},\eta_{it}^{1*}\right)\right]}{\partial\eta_t^i}\right]\times\left[\eta_t^i - \eta_t^{i*}\right] \geq 0$$

$$\forall\left(Q^1,\eta^1\right) \in \kappa^1. \quad (7)$$

where $\kappa^1 \equiv \left[\left(Q^1,\eta^1\right) \mid q_{jt}^i \geq 0, 0 \leq \eta_t^i \leq 1, \forall i, j, t\right]$.

B. The multi-dimensional decision-making behavior of the retailers with incentive and their optimality conditions

The retailers, in turn, are the intermediates among the manufacturers and consumers through commodity transaction.

They have also assumed to maximize the profits, minimize the risk and emission associated with the transaction. Although we also assumed that the retailers are involved in maximizing their incentives that associated with transaction and loading/unloading e, g. union pressure.

Thus the profit maximization problem with same notation (Cruz and Wakolbinger (2008)) for the retailers' j is presented as

Maximize

$$\sum_{t=1}^{T}\left[\sum_{k=1}^{K}\rho_{2kt}^{j}q_{kt}^{j}-c_{t}^{j}\left(q_{t}^{j}\right)-\sum_{i=1}^{I}c_{it}^{j}\left(q_{it}^{j},\eta_{jt}^{2}\right)-\sum_{k=1}^{K}c_{kt}^{j}\left(q_{kt}^{j},\eta_{kt}^{2}\right)-b_{t}^{j}\left(\eta_{jt}^{2}\right)-\sum_{i=1}^{I}\rho_{1jt}^{i}q_{jt}^{i}\right] \quad (8)$$

Subject to $\sum_{k=1}^{K}q_{kt}^{j}=\sum_{j=1}^{J}q_{jt}^{i}.....\forall t,$

$$q_{jt}^{i}\geq 0, q_{kt}^{j}\geq 0, \text{ and } 0\leq\eta_{t}^{i}\leq 1,\forall i,k,t.$$

Minimize $$\sum_{t=1}^{T}e_{t}^{j}\left(Q_{jt}^{2},\eta_{jt}^{2}\right) \quad (9)$$

Subject to $$q_{kt}^{j}\geq 0, \text{ and } 0\leq\eta_{t}^{j}\leq 1,\forall i,k,t.$$

The their goal is to minimize the risk and can be expressed as,

Minimize $$\sum_{t=1}^{T}r_{t}^{j}\left(Q_{jt}^{2},\eta_{jt}^{2}\right) \quad (10)$$

Subject to $q_{kt}^{j}\geq 0$, and $0\leq\eta_{t}^{j}\leq 1,\forall i,k,t.$

In addition to the above four mathematical formulation, we assume that each retailers j also has a target to maximize the total incentive level associated with the transaction, loading-unloading etc. can be expressed mathematically as,

Maximize $$I_{t}^{j}\left[B_{jt}^{2}\left(Q_{jt}^{2},\eta_{jt}^{2}\right).W_{jt}^{2}\left(Q_{jt}^{2},\eta_{jt}^{2}\right)\right] \quad (11)$$

Subject to $q_{kt}^{j}\geq 0$, $0\leq\eta_{t}^{j}\leq 1$, $\forall i,k,t.$

Therefore the equations (8), (9), (10) and (11) construct the retailer's profit objectives as,

Maximize

$$\sum_{t=1}^{T}\left[\sum_{k=1}^{K}\rho_{2kt}^{j}q_{kt}^{j}-c_{t}^{j}\left(q_{t}^{j}\right)-\sum_{i=1}^{I}c_{jt}^{i}\left(q_{jt}^{i},\eta_{it}^{2}\right)-\sum_{k=1}^{K}c_{kt}^{j}\left(q_{kt}^{j},\eta_{kt}^{2}\right)-b_{t}^{j}\left(\eta_{jt}^{2}\right)-\sum_{i=1}^{I}\rho_{1jt}^{i}q_{jt}^{i}-\omega_{2}^{j}\sum_{t=1}^{T}e_{t}^{j}\left(Q_{jt}^{2},\eta_{jt}^{2}\right)-\omega_{3}^{j}\sum_{t=1}^{T}r_{t}^{j}\left(Q_{jt}^{2},\eta_{jt}^{2}\right)+I_{t}^{j}\left[B_{jt}^{2}\left(Q_{jt}^{2},\eta_{jt}^{2}\right).W_{jt}^{2}\left(Q_{jt}^{2},\eta_{jt}^{2}\right)\right]\right] \quad (12)$$

Subject to $$\sum_{k=1}^{K}q_{kt}^{j}\leq\sum_{j=1}^{J}q_{jt}^{i}+\sum_{t=1}^{T}B_{t}^{i}q_{jt}^{i}+\sum_{t=1}^{T}W_{t}^{i}q_{jt}^{i}.....\forall t,$$

$$q_{jt}^{i}\geq 0, q_{kt}^{j}\geq 0,\ 0\leq\eta_{t}^{j}\leq 1,\ \forall i,k,t.$$

The equation (12) comprises with retailers profit maximization, weighted emission to be minimize, weighted risk to be minimize, and the last term highlights the weighted incentive, which is to be maximize.

Thus, the Nash-equilibrium condition for all retailers with incentives function characterized non-cooperative operation, can be mathematically expressed as the variation inequality in Cruz (2008) Bazaraa et al (1993) determine

$$\left(Q^{1*},Q^{2*},\eta^{2*},\lambda^{*}\right)\in\kappa^{2} \quad \text{satisfying}$$

$$\sum_{t=1}^{T}\sum_{i=1}^{I}\sum_{k=1}^{K}\left[\frac{\partial c_{kt}^{j}\left(q_{kt}^{j*},\eta_{jt}^{2*}\right)}{\partial q_{kt}^{j}}+\omega_{2}^{j}\frac{\partial e_{t}^{j}\left(q_{jt}^{2*},\eta_{jt}^{2*}\right)}{\partial q_{kt}^{j}}+\omega_{3}^{j}\frac{\partial r_{t}^{j}\left(q_{jt}^{2*},\eta_{jt}^{2*}\right)}{\partial q_{kt}^{j}}-\lambda_{jt}-\rho_{2kt}^{j*}-\frac{\partial I_{t}^{j}\left[B_{jt}^{2}\left(Q_{jt}^{2*},\eta_{jt}^{2*}\right),W_{jt}^{2}\left(Q_{jt}^{2*},\eta_{jt}^{2*}\right)\right]}{\partial q_{jt}^{i}}\right]\times\left[q_{kt}^{j}-q_{kt}^{j*}\right]$$

$$+\sum_{t=1}^{T}\sum_{i=1}^{I}\sum_{j=1}^{J}\left[\frac{\partial c_{jt}^{i}\left(q_{t}^{1*},\eta_{it}^{1*}\right)}{\partial q_{jt}^{i}}+\frac{\partial c_{t}^{j}\left(q_{t}^{j*}\right)}{\partial q_{jt}^{i}}+\omega_{2}^{j}\frac{\partial e_{jt}^{i}\left(Q_{jt}^{2*},\eta_{jt}^{2*}\right)}{\partial q_{jt}^{i}}+\omega_{3}^{j}\frac{\partial r_{jt}^{i}\left(Q_{jt}^{2*},\eta_{jt}^{2*}\right)}{\partial q_{jt}^{i}}+\rho_{1jt}^{1*}+\frac{\partial I_{t}^{i}\left[B_{it}^{1}\left(Q_{it}^{1*},\eta_{it}^{1*}\right),W_{it}^{1}\left(Q_{it}^{1*},\eta_{it}^{1*}\right)\right]}{\partial q_{jt}^{i}}-\lambda_{jt}\right]\times\left[q_{jt}^{i}-q_{jt}^{i*}\right]$$

$$+\sum_{t=1}^{T}\sum_{i=1}^{I}\sum_{j=1}^{J}\left[\frac{\partial\sum_{t=1}^{T}c_{it}^{j}\left(q_{jt}^{i*},\eta_{jt}^{2*}\right)}{\partial\eta_{t}^{j}}+\frac{\partial\sum_{t=1}^{T}c_{kt}^{j}\left(q_{kt}^{j*},\eta_{jt}^{2*}\right)}{\partial\eta_{t}^{j}}+\frac{\partial\sum_{t=1}^{T}b_{t}^{j}\left(\eta_{jt}^{2*}\right)}{\partial\eta_{t}^{j}}+\omega_{2}^{j}\frac{\partial\sum_{t=1}^{T}e_{t}^{j}\left(Q_{jt}^{2*},\eta_{jt}^{2*}\right)}{\partial\eta_{t}^{j}}+\omega_{3}^{j}\frac{\partial\sum_{t=1}^{T}r_{t}^{j}\left(Q_{jt}^{2*},\eta_{jt}^{2*}\right)}{\partial\eta_{t}^{j}}+\varpi_{4}\frac{\partial\sum_{t=1}^{T}I_{t}^{j}\left[B_{jt}^{2}\left(Q_{jt}^{2*},\eta_{jt}^{2*}\right),W_{jt}^{2}\left(Q_{jt}^{2*},\eta_{jt}^{2*}\right)\right]}{\partial\eta_{t}^{j}}\right]\times\left(\eta_{t}^{j}-\eta_{t}^{j*}\right)$$

$$+\sum_{j=1}^{J}\sum_{t=1}^{T}\left[\sum_{i=1}^{I}\left(q_{jt}^{i*}+B_{t}^{i*}q_{jt}^{i*}+W_{t}^{i*}q_{jt}^{i*}\right)-\sum_{k=1}^{K}q_{kt}^{j*}\right]\times\left[\lambda_{jt}-\lambda_{jt}^{*}\right]\geq 0$$

$$\forall\left(Q^{1},Q^{2},\eta^{2},\lambda\right)\in\kappa^{2}. \quad (13)$$

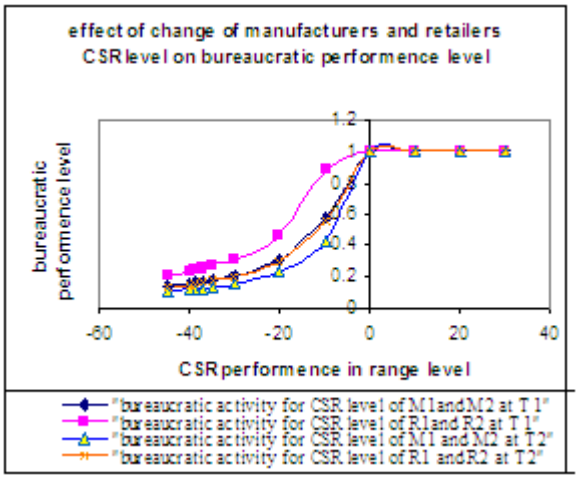
Where

$$\kappa^{2}\equiv\left[\left(Q^{1},Q^{2},\eta^{2},\lambda\right)\ \middle|\ q_{jt}^{i}\geq 0, q_{kt}^{j}\geq 0, 0\leq\eta_{t}^{j}\leq 1,\ \lambda_{jt}\geq 0,\ \forall i,j,k,t\right].$$

C. Equilibrium conditions for the demand markets including 'willingness to pay' for the CSR activity

Let us assume that there is a positive relationship between (i) retailer's product flow for consumers' willingness to pay and (ii) CSR activity by retailer j for the consumers' willingness to pay. However, the perception we are required to establish does not exist in under-developed countries and in the linkage among the socio-economic condition, environmental condition and CSR activities. Therefore, there is also a reverse relationship among the demand makers,

retailers, and manufacturers through incentive transaction. By taking into consideration the Cruz and Wakolbinger's (2008) analysis on CSR in the equilibrium conditions for consumers at demand market 'k' (cf. Samuelson (1952)) can be mathematically expressed as,



$$\rho_{2kt}^{j*} + c_{jt}^{k}\left(q_{kt}^{j*}, \eta_{jt}^{2*}\right) + w_{jt}^{k*}\left(q_{kt}^{j*}, \eta_{jt}^{2*}\right) \begin{cases} = \rho_{3t}^{k*} & if\ q_{kt}^{j*} > 0 \\ \geq \rho_{3t}^{k*} & if\ q_{kt}^{j*} = 0 \end{cases} \tag{14}$$

and

$$d_t^k\left(\rho_{3t}^{*}\right) \begin{cases} = \sum_{j=1}^{J} q_{kt}^{j*} & if\ \rho_{3t}^{k*} > 0, \\ \leq \sum_{j=1}^{J} q_{kt}^{j*} & if\ \rho_{3t}^{k*} = 0. \end{cases} \tag{15}$$

$w_t^{k*}\left(q_{kt}^{j*}, \eta_{jt}^{2*}\right)$ Implies 'consumers willingness to pay' at time t, associated with product flow from

'j' to 'k' and CSR activities performed by j.

Also

$$\sum_{j=1}^{J}\sum_{k=1}^{K}\sum_{t=1}^{T}\left[\rho_{2kt}^{j*} + c_{jt}^{k}\left(q_{kt}^{j*}, \eta_{jt}^{2*}\right) + w_t^{k*}\left(q_{kt}^{j*}, \eta_{jt}^{2*}\right) - \rho_{3t}^{k*}\right] \times \left[q_{kt}^{j} - q_{kt}^{j*}\right] + \sum_{j=1}^{J}\sum_{k=1}^{K}\sum_{t=}^{T} w_{jt}^{k*}\left(q_{kt}^{j*}, \eta_{jt}^{2*}\right) \times \left(\eta_t^{j} - \eta_t^{j*}\right)$$

$$+ \sum_{k=1}^{K}\sum_{t=1}^{T}\left[\sum_{j=1}^{J} q_{kt}^{j*} - d_t^k\left(\rho_{3t}^{*}\right)\right] \times \left[\rho_{3t}^{k} - \rho_{3t}^{k*}\right] \geq 0$$

$$\forall\left(Q^2, \rho_3\right) \in \kappa^3 \quad where\ \kappa^3 \equiv \left[\left(Q^2, \rho_3\right) \middle| \left(Q^2, \rho_3\right) \in R_{+}^{(1+J)KT}\right]. \tag{16}$$

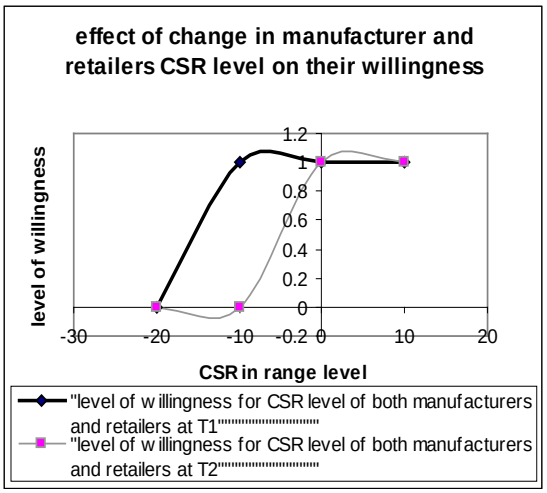
Therefore, through the equation no's (7), (13) and (16) we can construct the multi-dimensional supply chain network system but it is less required to analyze.

V. Result of the Models-Sketch

Following the different input data for the manufacturers, retailers and demand makers from Cruz et al (2008) and setting them in this new model we primarily get the equilibrium product transaction amounts

$q_{ji}^{i*} = q_{ki}^{j*} = 16.94 \quad for\ i = 1,\ 2,\ j = 1,\ 2$ in the first time period.

$q_{ji}^{i*} = q_{ki}^{j*} = 16.90 \quad for\ i = 1,\ 2,\ j = 1,\ 2$ in the second time period. The CSR levels get their upper is 1 for all time period. In equilibrium, all decision makers establish the level of willingness at 1 and the level of bureaucratic activity at 1, the autonomous CSR performance also 1, in both periods. The transaction cost, emission and risk in both period 1 and 2 are a function of CSR levels in the first and second periods. Again, the incentive function, bureaucratic activity function and willingness function also have given same wastage in both the first and second period. The result leads to lower product flow and lower price in the second periods. This explain that, we should concentrate on the political hierarchy and the lack of willingness to develop the environment for production and the product-services, socio-economic condition as well as the condition for global environment particularly in UDC.



There are lots of conspiracies on the measurement of the rank or level of bureaucratic activities and willingness as well as the measurement of their impact. Hence, in this study we attempt to show how changes in the parameters affect the disequilibrium results in the supply chain network. Due to major controversy on the measurement, we consider a wide range of values. In the first numerical example, we analyze the graphical impact of improvement or deterioration of bureaucratic activities for different CSR range level.

In the second, we have shown the impact of improvement or deterioration of willingness to take on CSR level. For all the abbreviations except the incentive function, we follow Cruz (2008) to analyze the CSR activity which is more inelastic at second period than in the first period for both the manufacturers and retailers.

Therefore, in the long run the sensitivity of CSR activity get staged as bureaucratic activity and become more and more negative i.e. If we suppose that there is minimum level of CSR activities, then in the long run the CSR activities will reach minimum level in a very short period if circumstances is getting very worse. Example-2 reveals that the CSR activities are more sensitive to both the manufacturers and retailers in the same time periods. However, at the range of 20 power of

willingness to CSR performance get zero for all the decision-makers.

VI. COMPUTATIONAL SKETCH:

To compute the model sketch we have analyzed the impact of changes in parameters in the multiperiod SCN model on bureaucratic activities and willingness level which consists of two manufacturer, two retailers and two demand makers with different cost functions, emission, risk and incentive function of quantity transaction and CSR level in two different time periods. However, only the incentive function, bureaucratic activity functions and willingness functions and their description for numerical analysis are shown in Table-5. The functions used in the numerical analysis can be categoried in the following manners: firstly, the production cost, demand function, CSR cost function are taken from the multi-period SCN model by Cruz et al (2008); secondly, the transaction cost, risk and emission function follow that analysis as a performing indicator of CSR; lastly, the incentive function for the decision makers and the required willingness function are shown in Table- 5. The manufacturers and retailers are influenced by incentive function, and is a quadratic function of CSR performance in case of bureaucratic activities. We use quadratic incentive junction in regularize supply chain context in this sensitivity analysis as it has been suggested in example Nagurney et al (2005).

Table 5

Notation	Description
$I_t^i\left[B_{it}^1\left(Q_{it}^1,\eta_{it}^1\right),W_{it}^1\left(Q_{it}^1,\eta_{it}^1\right)\right]=\sum_{j=1}^{2}\left[q_{jt}^i+\left(\sum_{t=1}^{2}B_t^i\right)\times q_{jt}^i+\left(\sum_{t=1}^{2}w_t^i\right)\times q_{jt}^i\right]-\sum_{j=1}^{2}\left[S_t^i-L_{1ijt}\times\left(\sum_{t=1}^{2}B_t^i\right)\times\eta_t^{i\,2}-G_{1ijt}\times\left(\sum_{t=1}^{2}W_t^i\right)\times\eta_t^i\right]$	Incentive associated with manufacturer i at period t.
$I_t^j\left[B_{jt}^2\left(Q_{jt}^2,\eta_{jt}^2\right),W_{jt}^2\left(Q_{jt}^2,\eta_{jt}^2\right)\right]=\sum_{k=1}^{2}\left[q_{kt}^j+\left(\sum_{t=1}^{2}B_t^j\right)\times q_{kt}^j+\left(\sum_{t=1}^{2}W_t^j\right)\times q_{kt}^j\right]-\sum_{k=1}^{2}\left[S_t^j-L_{2jkt}\times\left(\sum_{t=1}^{2}B_t^j\right)\times\eta_t^{j\,2}-G_{2jkt}\times\left(\sum_{t=1}^{2}W_t^j\right)\times\eta_t^j\right]$	Incentive associated with retailer j at period t
$w_{jt}^k\left(q_{kt}^j,\eta_{jt}^2\right)=1-\left(\sum_{t=1}^{t}\eta_t^j\right)$	The willing to give is based on unit ransaction with retailer j at period t.

The function for willingness to give in the demand markets, face a unit payment during product transaction with retailers. $L_{1ijt}\ \&\ L_{2jkt};G_{1ijt}\ \&\ G_{2jkt}$ represents parameters $\forall\quad i=1,2,\ j=1,2\ and\ t=1,2$. At the beginning of the study, we get that all the parameters consistent with the incentive function are equal to 1.Our parameter setting reflects that the bureaucratic influence for CSR level and the power of willingness for CSR level are assumed to be same. All the weights are set equal to 1. We have used the LINGO to solve these numerical examines.

VII. CONCLUSION AND FUTURE RESEARCH

Production efficiency can increase if we control CSR activity violation. Production efficiency with CSR activities can only be regulated if political officials and communities at large take an initiative for the betterment of present as well as future generation. The effect of indirect community participation is required to be neutral regardless of the shape of the characteristics of bureaucracy. As a result of regular indirect community participation and the willingness of political officialdom, sales (internal or external) can increase, and companies can become more profitable than holding the individualism thinking. Again, the investment through manufacturers, communities at large and the support from political officialdoms, the CSR activities can also increase the return on investment if and only if consumers prefer those commodities which have higher rank on CSR to keep price and quality constant. Therefore, it is very important for decision-makers to find the optimal level of investment in CSR activities in the first place so that people would be willing to pay for these activities raised overtime. The optimal levels of CSR activities are impacted by factors within or outside a firm as well as the general business environment.

The regularized SCN model has been connected basically through the willingness criterion. Here the willingness held by manufacturers for CSR activity, the willingness held by retailers for CSR performance and the willingness held by consumers through unit-consumption, when combined with bureaucratic activities, may be able to construct a motivational bridge to sustain the production of CSR model.

The numerical examples highlights the ultimate goal for the supply chain as a whole which may not always be achieved if each production unit in the supply chain determines the optimal level of CSR based on his/ her own costs and benefits only. It is important that CSR activities are coordinated among different firms, bureaucrats, and consumers in the supply chain to lead to a multitude of positive externalities. It has the potential to reduce the uncertainty in production unit, cost-effective environmental solution, uplift the consumer confidence and strenghen the relationship among consumers, retailers, and firms.

The model developed in this study provides a foundation for wide range of contemporary studies that attempt to examine assumptions in conceptual literature. In the first step it is required to empirically validate the following relationships: (i) the relationship between the level of bureaucratic activity and CSR level; (ii) the relationship between CSR level and willingness of the decision maker and consumer; (iii) the CSR level-incentive-profit relationships. Secondly, as an operational framework in global scenario, it is important to analyze how the concept of CSR is applied in different countries with different cultures, rules and regulations. Future researches can expand in international arena. Finally, we develop a dynamic model that may consider the rate of change of price, cost,

incentive and profit as the investment in CSR increases or decreases overtime.

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